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1980 PESTICIDE USE ON SOYBEANS IN THE
MAJOR PRODUCING STATES

by

Michael Hanthorn, Craig Osteen,
Robert McDowell, and Larry Roberson

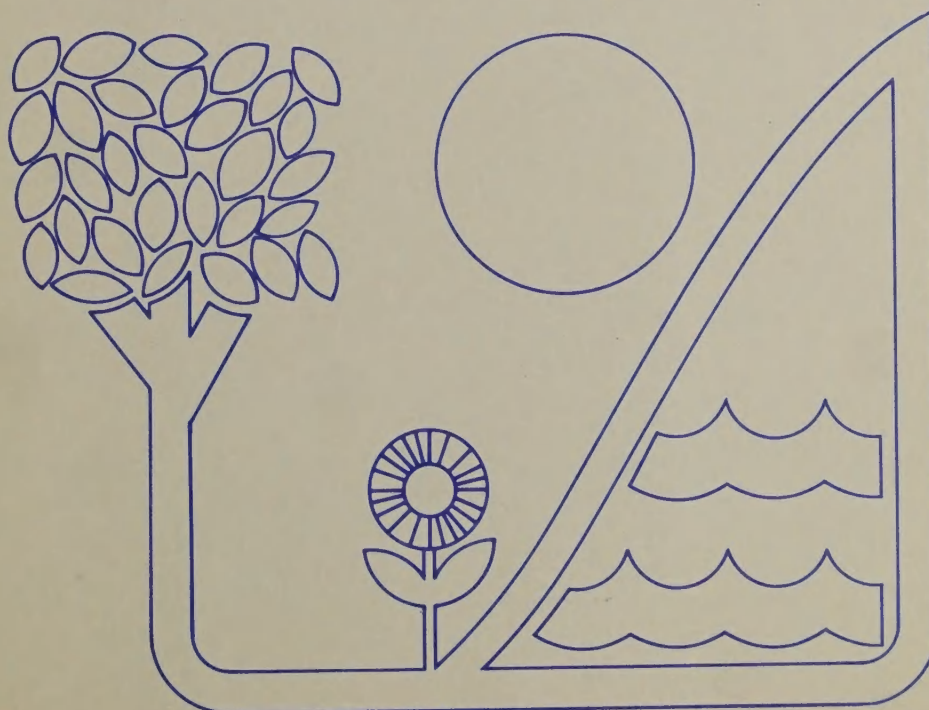
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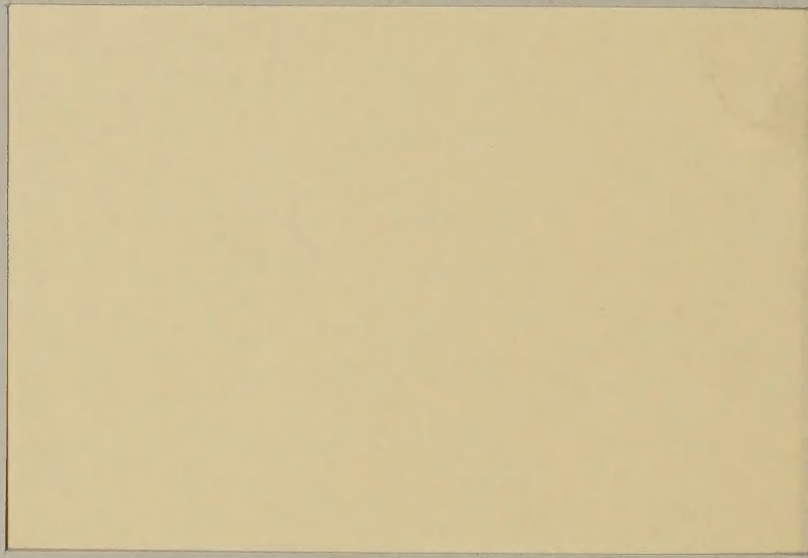
ERS Staff Report No. AGES820106

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Natural Resource Economics Division
Economic Research Service
U.S. Department of Agriculture
Washington, D.C. 20250

1980 PESTICIDE USE ON SOYBEANS IN THE MAJOR PRODUCING STATES. By Michael Hanthorn, Craig Osteen, Robert McDowell, and Larry Roberson; Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture, Washington, D.C. 20250; January 1982.

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ABSTRACT

Farmers reported that 124.6 million pounds (a.i.) of pesticides were applied to soybeans in the major producing States during 1980. This consisted of 114.4 million pounds (a.i.) of herbicides, 8 million pounds (a.i.) of insecticides, 1.5 million pounds (a.i.) of nematocides, and 600,000 pounds (a.i.) of fungicides. Pesticide acre-treatments totaled 106.6 million and consisted of 95.5 million with herbicides, 9.3 million with insecticides, 600,000 with nematocides, and 1.2 million with fungicides. The primary herbicides were alachlor, bentazon, and trifluralin. The major insecticides were carbaryl, methomyl, and methyl parathion. Aldicarb and ethylene dibromide were the primary nematocides and benomyl was the major fungicide. Herbicides were applied primarily to control cocklebur, crabgrass, foxtail, and Johnsongrass infestations. Insecticides were mainly applied to control armyworm and corn earworm infestations. Leaf blight, pod and stem blight, and root rot were the major diseases controlled with fungicides. Coefficients of variation were computed for acres of soybeans treated with specific pesticide materials.

Key words: Pesticides, herbicides, insecticides, nematocides, fungicides, active ingredient, acres treated, acre-treatments, application rates, primary target pests and diseases, soybeans, and major producing States.

* * * * *

* This paper was prepared for limited distribution to the research community outside the U.S. Department of Agriculture. Use of product names in this report is for identification only, and does not imply endorsement by the U.S. Department of Agriculture. *

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PREFACE

This report presents data at the national and regional level for pesticides applied to soybeans in the major producing States during 1980. Pesticide use data for the individual major producing States are available in the following ERS Staff Reports:

"1980 Pesticide Use on Soybeans in the North Central States"

"1980 Pesticide Use on Soybeans in the Mississippi Valley"

"1980 Pesticide Use on Soybeans in the Southeast".

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INTRODUCTION

This report presents pesticide use data for soybeans grown in the major producing States during 1980. The data include usage patterns and quantities of specific herbicides, insecticides, nematocides, and fungicides applied to soybeans. This information should be useful to policymakers, academic institutions, government agencies, and private and commercial entities in evaluating the impacts of regulatory actions on specific pesticides, conducting economic analyses of pesticide use, developing more effective pest management programs, and conducting pesticide market analyses.

METHODOLOGY AND TERMINOLOGY

The Economics and Statistics Service collected pesticide use data as part of the 1980 Soybean Objective Yield Survey. A total of 1,915 farmers were personally interviewed by enumerators in the 17 major soybean producing States. The sample size by region was as follows: North Central States, 1,045; Mississippi Valley, 560; and Southeast, 310.

Sample fields for each State were randomly selected from farmers who reported through the June Enumerative Survey that they had planted or intended to plant soybeans in 1980. Each soybean acre in a State had an equal probability of being selected so that the probability of a field being chosen was directly correlated to its size.

Several terms pertinent to this report are defined as follows. An "active ingredient" (a.i.) is that portion of a pesticide material that provides the control activity. "Acres treated" are the number of acres receiving one or more applications of a specific pesticide during the growing season. Acres treated with different pesticide materials cannot be summed because more than

one material may have been applied on a given acre during the growing season. Therefore, the addition of these numbers would result in multiple counting.

"Acre-treatments" are the number of acres treated with a pesticide material multiplied by the number of applications made during the growing season. Acre-treatments are summed for each material at the regional and national level. "Pesticide mixes" are two or more pesticide materials that are premixed during formulation or tank-mixed at the time of application.

Pesticide application rates vary as a result of weather conditions, soil type, weed spectrum, insect species, and disease type. Also, the method of application influences the amount of a material used per acre. Herbicide and foliar insecticide application rates are generally expressed as broadcast rates. The amount of a material applied on an acre in either a band, in-furrow, or spot application is generally one-fourth to one-third the amount applied in a broadcast application. The application rate listed for each material in this report is an aggregation of band, broadcast, in-furrow, and spot applications.

RELIABILITY OF ESTIMATES

Estimates based upon sample surveys have varying degrees of statistical reliability. Confidence in data depends upon sample size, sampling methods, and the variability of the responses. To provide the user of the data with some indication of the reliability of the estimates, coefficients of variation (CV's) are presented in Appendix Table 1. The CV is a measure of relative variation (expressed in percentage terms) and can be used to indicate the degree of confidence a user can place in the estimate. The smaller the CV, the more reliable the estimate.

In simplest terms, it can be said there is 95 percent confidence that the sample represents the true population and that the true value for the population

lies within an interval defined as the estimated value ± 2 CV's times the estimated value. For example, with a CV of 10 percent and an estimate of 40, the interval would be 32 to 48. However, there is also a 5 percent chance that the true value does not fall within the interval as defined above because the sample is not representative of the population.

CV's were calculated only for acres treated with specific pesticides. The estimates of acres treated are expected to have greater variation than other data reported. Consequently, for most other information included in this report, the level of reliability should be equal to or greater than reported for acres treated.

MAJOR PRODUCING STATES

Description

The major producing States are located in the North Central States, Mississippi Valley, and Southeast regions (Figure 1). The North Central States include Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, and Ohio. The Mississippi Valley comprises Arkansas, Kentucky, Louisiana, Mississippi, and Tennessee. The Southeast is Alabama, Georgia, North Carolina, and South Carolina.

Approximately 92 percent of the U.S. soybean acreage (64.8 million acres) was planted in these States in 1980, from which 93 percent of the national crop (1.7 billion bushels) was produced (Table 1). About 71 percent (1.3 billion bushels) of the national crop was grown in the North Central States, in which 57 percent (39.7 million acres) of the U.S. planted acreage was located. The Mississippi Valley accounted for 24 percent (16.6 million acres) of the U.S. planted acreage, from which 16 percent of the national crop (287 million bushels) was produced. About 6 percent of the total crop (116 million bushels)

Figure 1. States included in the 1980 Soybean Pesticide Use Survey



Table 1. Soybean acreage planted and harvested, production, and value in the major producing States, 1980

States	: Total acres a/	:	Total	:	Total
	: Planted	: Harvested	: production a/	:	value b/
	-----Million-----		Million bushels		Million dollars
<u>North Central States</u>					
Illinois	9.3	9.2	310		2,386
Indiana	4.4	4.4	158		1,214
Iowa	8.3	8.3	323		2,403
Kansas	1.6	1.4	24		182
Minnesota	4.8	4.8	152		1,081
Missouri	5.7	5.5	138		1,058
Nebraska	1.8	1.8	53		390
Ohio	3.8	3.8	135		1,036
Region	39.7 (57) <u>c/</u>	39.2 (58)	1,293 (71)		9,750 (71)
<u>Mississippi Valley</u>					
Arkansas	4.8	4.4	70		560
Kentucky	1.6	1.6	37		283
Louisiana	3.5	3.4	70		556
Mississippi	4.0	3.8	62		477
Tennessee	2.7	2.5	48		388
Region	16.6 (24)	15.7 (23)	287 (16)		2,264 (16)
<u>Southeast</u>					
Alabama	2.3	2.1	32		239
Georgia	2.5	2.2	26		194
North Carolina	2.0	1.9	36		280
South Carolina	1.7	1.6	22		173
Region	8.5 (12)	7.8 (11)	116 (6)		886 (6)
TOTAL	64.8 (92)	62.7 (92)	1,696 (93)		12,900 (93)

a/ "Crop Production-1980 Annual Summary", USDA, ESS, Crop Reporting Board, CrPr 2-1(81), January 14, 1981.

b/ "Field Crops-Production, Disposition, Value 1979-80", USDA, ESS, Crop Reporting Board, CrPr 1(81), April 1981.

c/ Numbers in parentheses represent percentage of U.S. total.

was grown on 12 percent of the U.S. planted acreage (8.5 million acres) in the Southeast. The farm value of soybeans grown in these three regions during 1980 was \$12.9 billion.

Trends in Pesticide Use

There was a substantial increase in the amount of acres planted to soybeans and treated with pesticides in the major producing States between 1972 and 1980. Acres planted increased by 47 percent from 44.1 to 64.8 million (Table 2). Acres treated with herbicides doubled from 29.6 to 59.6 million, while acres treated with insecticides increased fourteenfold from 500,000 to 7.2 million. The largest percentage increase in pesticide treated acreage occurred in the Southeast.

In 1980, 92 percent of the planted acreage in the major producing States was treated with herbicides and 11 percent was treated with insecticides. The percentage of planted acres treated with insecticides varied from 2 percent in the North Central States to 47 percent in the Southeast.

In 1980, nematocide and fungicide treated acreage each accounted for 1 percent of the total planted acreage (Table 3). Nematocide and fungicide use was not reported in these States during 1972. Nematocide use was greatest in the Southeast and fungicides were used primarily in the Mississippi Valley. Very little of either type of pesticide was used in the North Central States.

Pesticide Use

The major soybean weed, insect, and disease pests, as reported by farmers in the major producing States, are listed in Tables 4, 5, and 6, respectively. Although several pests may have been present at any given time and caused varying degrees of damage, farmers were asked to report what they perceived to be the primary target pest for each material applied to soybeans.

In 1980, farmers reported that foxtail was the primary target pest for 25

Table 2. Soybean acreage planted and treated for weed and insect control in the major producing States, 1972 and 1980

States	Planted acres		Treated acres				Percent of planted acres treated			
			Herbicides		Insecticides		Herbicides		Insecticides	
	1972	1980	1972	1980	1972	1980	1972	1980	1972	1980
	a/	b/	c/	d/	c/	d/	1972	1980	1972	1980
<hr/>										
----- Million ----- Percent -----										
<u>North Central States</u>										
Illinois	7.6	9.3	5.7	9.2	-	-	75	99	-	-
Indiana	3.7	4.4	3.0	4.3	-	.1	80	97	-	3
Iowa	6.0	8.3	5.1	8.1	-	-	83	97	-	-
Kansas	.9	1.6	.3	1.4	-	.1	37	92	-	5
Minnesota	3.3	4.8	2.6	4.6	-	-	81	96	-	-
Missouri	4.1	5.7	2.9	5.3	-	.04	72	93	-	1
Nebraska	.7	1.8	.4	1.6	-	.1	57	86	-	5
Ohio	3.1	3.8	2.2	3.6	-	.4	70	95	-	9
Region	29.4	39.7	22.2	38.1	-	.7	76	96	-	2
<u>Mississippi Valley</u>										
Arkansas	4.1	4.8	2.8	4.2	.1	.3	69	88	2	6
Kentucky	1.0	1.6	<u>e/</u>	1.6	<u>e/</u>	.1	<u>e/</u>	97	<u>e/</u>	5
Louisiana	1.7	3.5	1.0	3.0	.1	1.3	56	86	7	37
Mississippi	2.6	4.0	1.7	3.8	.03	.8	67	96	1	19
Tennessee	1.4	2.7	.8	2.5	-	.1	58	94	-	5
Region	10.8	16.6	6.3	15.1	.3	2.5	64 <u>f/</u>	91	3 <u>f/</u>	15
<u>Southeast</u>										
Alabama	.8	2.3	<u>e/</u>	1.8	<u>e/</u>	.6	<u>e/</u>	81	<u>e/</u>	24
Georgia	.7	2.5	<u>e/</u>	1.9	<u>e/</u>	1.5	<u>e/</u>	77	<u>e/</u>	62
North Carolina	1.3	2.0	.5	1.4	.1	.8	43	70	10	40
South Carolina	1.1	1.7	.6	1.3	.1	1.1	50	76	10	64
Region	3.9	8.5	1.1	6.4	.2	4.0	46 <u>g/</u>	76	10 <u>g/</u>	47
TOTAL	44.1	64.8	29.6	59.6	.5	7.2	71 <u>h/</u>	92	1 <u>h/</u>	11

- None reported.

a/ "Agricultural Statistics, 1974", U.S. Department of Agriculture.

b/ "Crop Production-1980 Annual Summary", USDA, ESS, Crop Reporting Board, CrPr 2-1(81), January 14, 1981.

c/ Herman W. Delvo, "1972 Soybean Objective Yield Survey", USDA, ERS, Farm Production Economics Division, 1972, (unpublished).

d/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

e/ Not surveyed in 1972.

f/ Computed excluding planted acres for Kentucky.

g/ Computed excluding planted acres for Alabama and Georgia.

h/ Computed excluding planted acres for Alabama, Georgia, and Kentucky.

Table 3. Soybean acreage planted and treated for nematode and disease control in the major producing States, 1980 a/

States	: Planted : acres b/	: Treated acres : Nematicides	: Fungicides	: Percent of planted : acres treated	
				Nematicides	Fungicides
	Million	Thousand		Percent	
<u>North Central States c/</u>					
Indiana	4.4	39	-	0.9	-
Iowa	8.3	15	-	.2	-
Missouri	5.7	-	46	-	.8
Nebraska	1.8	-	31	-	2
Other	19.5	-	-	-	-
Region	39.7	54	77	.001	.002
<u>Mississippi Valley</u>					
Arkansas	4.8	35	70	.7	1
Kentucky	1.6	-	-	-	-
Louisiana	3.5	-	268	-	8
Mississippi	4.0	-	207	-	5
Tennessee	2.7	33	65	1	2
Region	16.6	68	610	.4	4
<u>Southeast</u>					
Alabama	2.3	161	32	7	1
Georgia	2.5	-	71	-	3
North Carolina	2.0	87	58	4	3
South Carolina	1.7	283	47	17	3
Region	8.5	531	208	6	2
TOTAL	64.8	653	895	1	1

- None reported.

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ "Crop Production-1980 Annual Summary", USDA, ESS, Crop Reporting Board, CrPr 2-1(81), January 14, 1981.

c/ Nematicide use was not reported in Illinois, Kansas, Minnesota, Missouri, Nebraska, or Ohio. Fungicide use was not reported in Illinois, Indiana, Iowa, Kansas, Minnesota, or Ohio.

percent of the herbicide acre-treatments, cocklebur for 24 percent, crabgrass for 8 percent, and Johnsongrass for 8 percent (Table 4). In the North Central States, morningglory and velvetleaf were reported as significant problems, whereas crabgrass and Johnsongrass were not. Cocklebur, crabgrass, and Johnsongrass were major weed pests in the Mississippi Valley, while foxtail was less of a problem than in the other regions. Southeast growers reported that crabgrass was a significant pest, whereas foxtail was not, relative to the other regions.

Armyworm, corn earworm, and cabbage looper were the primary target pests for 29, 30, and 8 percent, respectively, of the insecticide acre-treatments (Table 5). About one-half of the fungicide acre-treatments were made for pod and stem blight control and the other half were made to suppress anthracnose, brown spot, leaf blight, leaf spot, and root rot infestations (Table 6).

About 124.6 million pounds (a.i.) of pesticides were applied to soybeans in 1980 (Table 7). Of these, 78.9 million pounds were single material herbicides, 35.5 million pounds were herbicide mixes, 5.6 million pounds were single material insecticides, 2.4 million pounds were insecticide mixes, 1.5 million pounds were nematicides, and 600,000 pounds were fungicides. Application rates for herbicides, applied alone and in mixes, were 1 and 2 pounds (a.i.) per acre-treatment, respectively. Insecticide application rates averaged 0.7 pound (a.i.) per acre-treatment for single materials and 1.6 pounds (a.i.) per acre-treatment for mixes. Nematicides were applied at an average rate of 2.5 pounds (a.i.) per acre-treatment. Fungicide rates averaged 0.4 pound (a.i.) per acre-treatment for single materials and 1 pound (a.i.) per acre-treatment for mixes.

Farmers made 106.6 million pesticide acre-treatments, comprised of 77.8 million with single material herbicides, 17.7 million with herbicide mixes, 7.8 million with single material insecticides, 1.5 million with insecticide mixes, 600,000 with nematicides, 1 million with single material fungicides, and 200,000

Table 4. Percentage of soybean herbicide acre-treatments by primary weeds controlled as reported by farmers in the major producing regions, 1980 a/

	:	North	:	:	:
	:	Central	:	Mississippi	:
Pests	:	States	:	Valley	:
	:		:	Southeast	:
				Total	

	<u>Percent</u>				
<u>Grasses</u>					
Barnyardgrass	1	2	1	1	
Broadleaf signalgrass	1	3	3	2	
Crabgrass	1	17	25	8	
Foxtail	40	3	-	25	
Johnsongrass	2	21	8	8	
Panicum	1	1	2	1	
Shattercane	1	1	-	1	
Other	4	4	6	5	
<u>Broadleaf weeds</u>					
Cocklebur	19	33	34	24	
Morningglory	12	6	4	3	
Pigweed	4	3	5	4	
Ragweed	3	1	2	3	
Sicklepod	1	1	5	1	
Smartweed	4	1	1	2	
Velvetleaf	10	-	-	6	
Other	7	3	4	6	

- None reported.

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

Table 5. Percentage of soybean insecticide acre-treatments by primary insects controlled as reported by farmers in the major producing regions, 1980 a/

	: North	: Mississippi	: Southeast	: Total
Insects	: Central	: Valley	:	:
	States			
	<u>Percent</u>			
Armyworm	13	30	31	29
Bean leaf beetle	10	6	2	4
Cabbage looper	-	10	8	8
Corn earworm	12	16	39	30
Cutworm	-	5	4	4
Grasshopper	8	6	2	4
Green cloverworm	-	-	2	1
Mexican bean beetle	45	-	-	3
Other beetles	-	3	3	3
Spider mite	-	-	2	1
Threecornered alfalfa hopper	-	3	-	1
Velvetbean caterpillar	-	12	4	6
Other	12	9	3	6

- None reported.

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

Table 6. Percentage of soybean fungicide acre-treatments by primary diseases controlled as reported by farmers in the major producing regions, 1980 a/

	:	North	:	:	:
	:	Central	:	Mississippi	:
Diseases	:	States	:	Valley	:
	:		:	Southeast	:
	:		:	Total	:

			<u>Percent</u>	
Anthracnose	-	5	23	10
Brown spot	-	19	-	11
Leaf blight	-	20	9	15
Leaf spot	-	5	-	3
Pod and stem blight	-	42	68	48
Root rot	100	9	-	13

- None reported.

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

Table 7. Usage patterns and quantities of specific pesticides applied to soybeans in the major producing States, 1980 a/

Pesticides	: Acres <u>b/</u>	: Acre- <u>c/</u>	: Pounds of active ingredient	
	: treated	: treatments	: Total	: Per treatment
----- Million -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	11.1	11.1	23.4	2.1
Bentazon	12.3	12.8	9.9	.8
Chloramben	3.2	3.2	4.9	1.5
Fluchloralin	2.1	2.1	2.0	1.0
Glyphosate	2.6	2.8	2.3	.8
Linuron	3.6	3.7	2.2	.6
Metribuzin	9.6	9.7	4.7	.5
Trifluralin	24.1	24.4	21.0	.9
Other	-	8.0	8.5	1.1
Total	-	77.8	78.9	1.0
<u>Tank-mix materials</u>				
Alachlor + linuron	2.1	2.1	4.1+1.4	1.9+ .7
Alachlor + metribuzin	2.5	2.5	5.5+1.4	2.2+ .5
Dinoseb + naptalam	1.7	1.8	1.1+2.1	.6+1.2
Metribuzin + trifluralin	5.6	5.6	2.6+5.2	.5+ .9
Other	-	5.7	12.1	2.1
Total	-	17.7	35.5	2.0
Total herbicides	-	95.5	114.4	1.2
INSECTICIDES				
<u>Single materials</u>				
Carbaryl	1.5	1.9	2.1	1.1
Methomyl	2.2	3.1	1.4	.5
Methyl parathion	.8	1.0	.6	.7
Toxaphene	.4	.6	1.0	1.8
Other	-	1.2	.5	.4
Total	-	7.8	5.6	.7
<u>Tank-mix materials</u>				
EPN + methyl parathion	.2	.3	.2+ .2	.7+ .7
Methyl parathion + toxaphene	.6	.8	.8+ .9	.9+1.1
Other	-	.4	.4	1.0
Total	-	1.5	2.4	1.6
Total insecticides	-	9.3	8.0	.9

-- continued

Table 7. Usage patterns and quantities of specific pesticides applied to soybeans in the major producing States, 1980 a/ -- continued

Pesticides	: Acres <u>b/</u>	: Acre- <u>c/</u>	: Pounds of active ingredient	
	: treated	: treatments	: Total	: Per treatment
----- <u>Million</u> -----				
NEMATOCIDES				
Aldicarb	.2	.2	.3	1.3
Ethoprop	.05	.05	.1	2.2
Ethylene dibromide	.1	.1	.8	5.5
Other	-	.3	.3	1.0
Total	-	.6	1.5	2.5
FUNGICIDES				
<u>Single materials</u>				
Benomyl	.6	.8	.2	.3
Other	-	.2	.2	1.0
Total	-	1.0	.4	.4
<u>Tank-mix materials</u>				
Benomyl + other	-	.09	.09+ .06	1.0+ .7
PCNB + etridiazole	.1	.1	.01+ .001	.1+ .02
Total	-	.2	.2	1.0
Total fungicides	-	1.2	.6	.5
TOTAL	-	106.6	124.6	1.2

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides, insecticides, nematocides, and fungicides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

with fungicide mixes.

One-third (24.4 million) of the single material herbicide acre-treatments were made with trifluralin. Alachlor, bentazon, and metribuzin acre-treatments totaled 11.1, 12.8, and 9.7 million, respectively. In total, these accounted for 42 percent of the single material herbicide acre-treatments. Metribuzin plus trifluralin accounted for one-third (5.6 million) of the herbicide mix acre-treatments. One-fourth of these acre-treatments were alachlor combined separately with linuron (2.1 million) and metribuzin (2.5 million).

One-half of the alachlor, 9 percent of the metribuzin, and 40 percent of the trifluralin acre-treatments were made to control foxtail infestations (Appendix Table 2). Also, crabgrass and Johnsongrass control accounted for 17 and 18 percent, respectively, of the trifluralin acre-treatments. Three-fourths of the bentazon and one-third of the metribuzin acre-treatments were made for cocklebur control (Appendix Table 3).

About 40 percent (3.1 million) of the single material insecticide acre-treatments were made with methomyl, while carbaryl and methyl parathion acre-treatments totaled 1.9 and 1 million (24 and 13 percent), respectively (Table 7). EPN plus methyl parathion constituted 300,000 (20 percent) of the insecticide mix acre-treatments and methyl parathion plus toxaphene acre-treatments totaled 800,000 (53 percent). Armyworm control accounted for 40 percent of the carbaryl, 23 percent of the methomyl, and 19 percent of the methyl parathion acre-treatments (Appendix Table 4). Corn earworm control comprised 20 percent of the carbaryl and 47 percent of the methomyl acre-treatments. One-fourth of the methyl parathion acre-treatments were made for velvetbean caterpillar control.

Aldicarb accounted for one-third (200,000) of the nematicide acre-treatments (Table 7). Ethylene dibromide acre-treatments totaled 100,000 (17 percent). Benomyl comprised 80 percent (800,000) of the single material fungicide

acre-treatments. One-half (100,000) of the fungicide mix acre-treatments were PCNB plus etridiazole and the other half were benomyl plus other pesticides. Pod and stem blight was the primary target disease for 70 percent of the benomyl acre-treatments (Appendix Table 5).

NORTH CENTRAL STATES

In 1980, farmers in the North Central States planted 39.7 million acres of soybeans and treated 38.1 million with herbicides, 700,000 with insecticides, 54,000 with nematicides, and 77,000 with fungicides (Tables 2 and 3). About 78 million pounds (a.i.) of pesticides were applied to soybeans, consisting of 50.5 million pounds of single material herbicides, 26.6 million pounds of herbicide mixes, 700,000 pounds of insecticides, 40,000 pounds of nematicides, and 120,000 pounds of fungicides (Table 8). Application rates for herbicides, applied alone and in mixes, were 1.1 and 2.1 pounds (a.i.) per acre-treatment, respectively. Insecticide application rates averaged 1.1 pounds (a.i.) per acre-treatment. Nematicide and fungicide rates averaged 0.6 and 1.6 pounds (a.i.) per acre-treatment, respectively.

Farmers made 58.2 million pesticide acre-treatments, comprised of 44.8 million with single material herbicides, 12.6 million with herbicide mixes, 700,000 with insecticides, 60,000 with nematicides, and 80,000 with fungicides.

Trifluralin totaled 13.5 million (30 percent) of the single material herbicide acre-treatments. Alachlor, bentazon, and metribuzin accounted for 19.3 million acre-treatments, or 43 percent of the same total. Forty percent (5 million) of the herbicide mix acre-treatments were made with metribuzin plus trifluralin. Alachlor plus linuron comprised 1.8 million (14 percent) of the herbicide mix acre-treatments and alachlor plus metribuzin acre-treatments totaled 2.2 million (17 percent).

Table 8. Usage patterns and quantities of specific pesticides applied to soybeans in the North Central States, 1980 a/

Pesticides	: Acres <u>b/</u> : treated	: Acre- <u>c/</u> : treatments	: Pounds of active ingredient Total	: Per treatment
<hr/>				
<div>-----<u>Million</u>-----</div>				
HERBICIDES				
<u>Single materials</u>				
Alachlor	7.9	7.9	16.8	2.1
Bentazon	6.1	6.1	5.6	.9
Chloramben	3.1	3.1	4.8	1.5
Glyphosate	1.6	1.8	1.7	.9
Linuron	2.6	2.7	1.7	.6
Metribuzin	5.3	5.3	2.5	.5
Trifluralin	13.2	13.5	11.8	.9
Other	-	4.4	5.6	1.3
Total	-	44.8	50.5	1.1
 <u>Tank-mix materials</u>				
Alachlor + chloramben	.4	.4	1.0+ .6	2.4+1.5
Alachlor + linuron	1.8	1.8	3.4+1.2	1.9+ .7
Alachlor + metribuzin	2.1	2.2	4.8+1.2	2.2+ .6
Dinoseb + naptalam	.4	.4	.3+ .6	.7+1.3
Metribuzin + trifluralin	4.9	5.0	2.3+4.7	.5+ .9
Other	-	2.8	6.5	2.3
Total	-	12.6	26.6	2.1
 Total herbicides	-	57.4	77.1	1.3
 INSECTICIDES				
Carbaryl	.4	.4	.4	1.1
Dimethoate	.06	.06	.03	.5
Methyl parathion + toxaphene	.1	.1	.1+ .1	.8+ .8
Other	-	.1	.07	.7
Total	-	.7	.7	1.1
 NEMATICIDES				
Total <u>d/</u>	-	.06	.04	.6
 FUNGICIDES				
Total <u>d/</u>	-	.08	.12	1.6
 TOTAL PESTICIDES	-	58.2	78.0	1.3

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides, insecticides, nematicides, and fungicides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Specific materials not reported because of a limited number of observations.

The primary target pest for two-thirds of the alachlor, 16 percent of the metribuzin, and 71 percent of the trifluralin acre-treatments was foxtail (Appendix Table 2). About 55 percent of the bentazon acre-treatments were made for cocklebur control and 17 percent were made to reduce velvetleaf infestations (Appendix Table 3). One-third of the metribuzin acre-treatments were made for cocklebur control and 15 percent were made for velvetleaf control.

Carbaryl accounted for 400,000 (57 percent) of the insecticide acre-treatments, while methyl parathion plus toxaphene acre-treatments totaled 100,000 (14 percent) (Table 8). Farmers reported that a smaller proportion of insecticide acre-treatments was made to control armyworm and corn earworm infestations and that a much larger proportion was made for Mexican bean beetle control in the North Central States than in the other regions (Table 5). Two-thirds of the carbaryl acre-treatments were made to suppress Mexican bean beetle infestations and one-fourth were made for armyworm and bean leaf beetle control (Appendix Table 4). All of the methomyl acre-treatments were made to suppress corn earworm infestations.

Nematicide acre-treatments totaled 60,000 and fungicide acre-treatments totaled 80,000 (Table 8). All fungicide materials were used for root rot control (Table 6).

MISSISSIPPI VALLEY

In 1980, Mississippi Valley farmers planted 16.6 million acres of soybeans and treated 15.1 million with herbicides, 2.5 million with insecticides, 68,000 with nematicides, and 610,000 with fungicides (Tables 2 and 3). Approximately 28.5 million pounds (a.i.) of pesticides were applied to soybeans (Table 9). Of these, 22 million pounds were single material herbicides, 4 million pounds were herbicide mixes, 1.3 million pounds were single material insecticides,

Table 9. Usage patterns and quantities of specific pesticides applied to soybeans in the Mississippi Valley, 1980 a/

Pesticides	: Acres <u>b/</u> : Acre- <u>c/</u> :		Pounds of active ingredient	
	: treated	: treatments:	Total	: Per treatment
----- <u>Thousand</u> -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	2,142	2,142	4,857	2.3
Bentazon	5,186	5,526	3,503	.6
Fluchloralin	1,188	1,188	1,061	.9
Glyphosate	834	955	551	.6
Linuron	781	781	423	.5
Metribuzin	3,435	3,455	1,651	.5
Pendimethalin	879	879	920	1.0
Trifluralin	8,206	8,210	7,209	.9
Other	-	2,276	1,808	.8
Total	-	25,412	21,983	.9
<u>Tank-mix materials</u>				
Acifluorfen + bentazon	330	330	97+176	.3+ .5
Alachlor + metribuzin	255	255	537+97	2.1+ .4
Bentazon + 2,4-DB	288	288	155+24	.5+ .1
Dinoseb + naptalam	640	798	366+701	.5+ .9
Metribuzin + trifluralin	347	347	201+338	.6+1.0
Other	-	924	1,303	1.4
Total	-	2,942	3,995	1.4
Total herbicides	-	28,354	25,978	.9
INSECTICIDES				
<u>Single materials</u>				
Carbaryl	249	287	341	1.2
Methomyl	490	524	233	.4
Methyl parathion	533	725	451	.6
Other	-	574	259	.5
Total	-	2,110	1,284	.6
<u>Tank-mix materials</u>				
EPN + methyl parathion	211	283	207+207	.7+ .7
Methyl parathion + toxaphene	324	363	274+342	.8+ .9
Total	-	646	1,030	1.6
Total insecticides	-	2,756	2,314	.8
NEMATICIDES				
Total <u>d/</u>	-	68	51	.8

-- continued

Table 9. Usage patterns and quantities of specific pesticides applied to soybeans in the Mississippi Valley, 1980 a/ -- continued

Pesticides	: Acres <u>b/</u>	: Acre- <u>c/</u>	: Pounds of active ingredient	
	: treated	: treatments:	Total	: Per treatment
	----- <u>Thousand</u> -----			
FUNGICIDES				
Benomyl	406	517	136	.3
PCNB + etridiazole	102	102	7+2	.1+ .01
Other	-	102	56	.5
Total	-	721	201	.3
 TOTAL PESTICIDES	 -	 31,899	 28,544	 .9

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides, insecticides, nematocides, and fungicides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Specific materials not reported because of a limited number of observations.

1 million pounds were insecticide mixes, 51,000 pounds were nematicides, and 201,000 pounds were fungicides. Application rates for herbicides, applied alone and in mixes, were 0.9 and 1.4 pounds (a.i.) per acre-treatment, respectively. Insecticide application rates averaged 0.6 pound (a.i.) per acre-treatment for single materials and 1.6 pounds (a.i.) per acre-treatment for mixes. Nematicide and fungicide rates averaged 0.8 and 0.3 pound (a.i.) per acre-treatment, respectively.

Farmers made 31.9 million pesticide acre-treatments, comprised of 25.4 million with single material herbicides, 2.9 million with herbicide mixes, 2.1 million with single material insecticides, 646,000 with insecticide mixes, 68,000 with nematicides, and 721,000 with fungicides.

Trifluralin accounted for 8.2 million (32 percent) of the single material herbicide acre-treatments. Also, 5.5 million (22 percent) were bentazon, 3.5 million (14 percent) were metribuzin, and 2.1 million (8 percent) were alachlor. About 798,000 (27 percent) of the herbicide mix acre-treatments were made with dinoseb plus naptalam. Approximately the same proportion of acre-treatments were made with four other herbicide mixes. These totaled 330,000 (11 percent) with acifluorfen plus bentazon, 255,000 (9 percent) with alachlor plus metribuzin, 288,000 (10 percent) with bentazon plus 2,4-DB, and 347,000 (12 percent) with metribuzin plus trifluralin.

Farmers reported that a greater proportion of herbicide acre-treatments was made to control crabgrass and Johnsongrass infestations and a smaller proportion was made for foxtail control in the Mississippi Valley than in the other regions (Table 4). One-fourth of the alachlor acre-treatments were made for crabgrass control, while one-half were made to reduce barnyardgrass, broad-leaf signalgrass, cocklebur, foxtail, Johnsongrass, and pigweed infestations (Appendix Tables 2 and 3). Cocklebur control accounted for 92 percent of the

bentazon acre-treatments and 35 percent of the metribuzin acre-treatments (Appendix Table 3). Also, 13 percent of the metribuzin acre-treatments were made to control morningglory infestations. Trifluralin acre-treatments totaled 31 and 44 percent, respectively, for crabgrass and Johnsongrass control (Appendix Table 2).

One-third (725,000) of the single material insecticide acre-treatments were methyl parathion and one-fourth (524,000) were methomyl (Table 9). Carbaryl acre-treatments totaled 287,000 (13 percent). About 363,000 (56 percent) of the insecticide mix acre-treatments were methyl parathion plus toxaphene, while 283,000 (44 percent) were EPN plus methyl parathion. Armyworm control accounted for 87 percent of the carbaryl, 36 percent of the methomyl, and 10 percent of the methyl parathion acre-treatments (Appendix Table 4). Also, methomyl acre-treatments totaled 38 percent for corn earworm control and 13 percent for cabbage looper control. One-third of the methyl parathion acre-treatments were made to suppress velvetbean caterpillar infestations and 22 percent were made for cabbage looper and threecornered alfalfa hopper control.

Nematicide acre-treatments totaled 68,000 (Table 9). Benomyl accounted for 72 percent (517,000) of the fungicide acre-treatments, while PCNB plus etridiazole acre-treatments comprised 14 percent (102,000). About 59 and 27 percent of the respective benomyl acre-treatments were made to control pod and stem blight and leaf blight (Appendix Table 5). All of the PCNB plus etridiazole was used for brown spot control.

SOUTHEAST

During the 1980 growing season, 8.5 million acres of soybeans were planted in the Southeast, of which 6.4 million were treated with herbicides, 4 million were treated with insecticides, 531,000 were treated with nematicides, and

208,000 were treated with fungicides (Tables 2 and 3). About 18.1 million pounds (a.i.) of pesticides were applied to soybeans (Table 10). Of these, 6.5 million were single material herbicides, 4.8 million were herbicide mixes, 3.9 million were single material insecticides, 1.2 million were insecticide mixes, 1.4 million were nematicides, and 234,000 were fungicides. Application rates for herbicides, applied alone and in mixes, were 0.9 and 2.2 pounds (a.i.) per acre-treatment, respectively. Insecticide application rates averaged 0.8 pound (a.i.) per acre-treatment for single materials and 1.6 pounds (a.i.) per acre-treatment for mixes. Nematicide and fungicide rates averaged 2.6 and 0.6 pounds (a.i.) per acre-treatment, respectively.

Farmers made 16.4 million acre-treatments, comprised of 7.5 million with single material herbicides, 2.2 million with herbicide mixes, 5 million with single material insecticides, 764,000 with insecticide mixes, 555,000 with nematicides, and 384,000 with fungicides.

About 2.8 million (37 percent) of the single material herbicide acre-treatments were trifluralin, while alachlor, bentazon, and metribuzin acre-treatments totaled 3.2 million (42 percent). Dinoseb plus naptalam acre-treatments accounted for 587,000 (27 percent) of the herbicide mix acre-treatments. Also, one-fourth (553,000) of these acre-treatments were made with alachlor plus linuron and metribuzin plus trifluralin.

Crabgrass control accounted for 35 percent of the alachlor acre-treatments and 50 percent of the trifluralin acre-treatments (Appendix Table 2). About 12 percent of the alachlor, 90 percent of the bentazon, 41 percent of the metribuzin, and 15 percent of the trifluralin acre-treatments were made to reduce cocklebur infestations (Appendix Table 3). Approximately 18 percent of the metribuzin acre-treatments were made to control morningglory infestations and 15 percent of the trifluralin acre-treatments were made for Johnsongrass control.

Table 10. Usage patterns and quantities of specific pesticides applied to soybeans in the Southeast, 1980 a/

Pesticides	: Acres <u>b/</u> : Acre- <u>c/</u> :		Pounds of active ingredient	
	: treated	: treatments:	Total	: Per treatment
----- <u>Thousand</u> -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	1,082	1,082	1,719	1.6
Bentazon	1,085	1,176	765	.7
Metribuzin	896	896	481	.5
Pendimethalin	262	262	252	1.0
Trifluralin	2,713	2,769	2,000	.7
Other	-	1,297	1,243	1.0
Total	-	7,482	6,460	.9
<u>Tank-mix materials</u>				
Alachlor + linuron	263	263	593+221	2.3+ .8
Dinoseb + naptalam	587	587	428+839	.7+1.4
Metribuzin + trifluralin	290	290	107+218	.4+1.8
Other	-	1,068	2,433	2.3
Total	-	2,208	4,839	2.2
Total herbicides	-	9,690	11,299	1.2
INSECTICIDES				
<u>Single materials</u>				
Carbaryl	877	1,282	1,358	1.1
Methomyl	1,716	2,542	1,198	.5
Methyl parathion	248	248	190	.8
Parathion	144	208	187	.9
Toxaphene	342	484	889	1.8
Other	-	273	91	.3
Total	-	5,037	3,913	.8
<u>Tank-mix materials</u>				
Carbaryl + methyl parathion	36	107	24+18	.2+ .2
Methomyl + other	-	142	32+89	.2+ .6
Methyl parathion + toxaphene	150	324	372+425	1.1+1.3
Other	-	159	83	.5
Total	-	764	1,197	1.6
Total insecticides	-	5,801	5,110	.9
NEMATOCIDES				
Aldicarb	214	214	279	1.3
Ethoprop	53	53	117	2.2
Ethylene dibromide	142	142	783	5.5
Other	-	146	245	1.7
Total	-	555	1,424	2.6

-- continued

Table 10. Usage patterns and quantities of specific pesticides applied to soybeans in the Southeast, 1980 a/ -- continued

Pesticides	: Acres <u>b/</u>	: Acre- <u>c/</u>	: Pounds of active ingredient	
	: treated	: treatments:	Total	Per treatment
	----- <u>Thousand</u> -----			
FUNGICIDES				
Benomyl	150	297	83	.3
Benomyl + other	-	87	90+61	1.0+ .7
Total	-	384	234	.6
TOTAL PESTICIDES	-	16,430	18,067	1.1

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides, insecticides, nematocides, and fungicides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

Methomyl totaled 2.5 million (45 percent) of the single material insecticide acre-treatments (Table 10). About 1.3 million (23 percent) were carbaryl. Carbaryl plus methyl parathion accounted for 107,000 (14 percent) of the insecticide mix acre-treatments and methyl parathion plus toxaphene acre-treatments totaled 324,000 (24 percent). One-fifth (142,000) of the insecticide mix acre-treatments were methomyl plus other insecticides.

The primary target pests for 37 and 30 percent of the carbaryl acre-treatments were armyworm and corn earworm, respectively (Appendix Table 4). Corn earworm was the primary target pest for one-half of the methomyl acre-treatments and armyworm was the primary target pest for one-fifth. Armyworm control accounted for 43 percent of the methyl parathion acre-treatments and velvetbean caterpillar control accounted for 10 percent.

Aldicarb and ethylene dibromide constituted 356,000 (64 percent) of the nematocide acre-treatments (Table 10). Three-fourths (297,000) of the fungicide acre-treatments were made with benomyl and the remainder (87,000) were benomyl plus other pesticides. About 88 percent of the benomyl acre-treatments were made to control pod and stem blight and 12 percent were made for leaf blight suppression (Appendix Table 5).

REFERENCES

1. Delvo, Herman W., "1972 Soybean Objective Yield Survey", USDA, ERS, Farm Production Economics Division, 1972, (unpublished).
2. U.S. Department of Agriculture, "Agricultural Statistics, 1974".
3. USDA, ESS, Crop Reporting Board, "Crop Production-1980 Annual Summary", CrPr 2-1(81), January 14, 1981.
4. USDA, ESS, Crop Reporting Board, "Field Crops-Production, Disposition, Value 1979-80", CrPr 1(81), April 1981.

Appendix Table 1. Coefficients of variation for acres of soybeans treated with specific pesticides in the major producing regions, 1980 a/ b/

Pesticides	: North Central : States	: Mississippi : Valley	: : Southeast	: : Total
	----- <u>Percent</u> -----			
HERBICIDES				
<u>Single materials</u>				
Alachlor	7	11	16	6
Bentazon	8	6	15	5
Chloramben	12	<u>c/</u>	<u>c/</u>	12
Fluchloralin	25	16	58	13
Glyphosate	17	18	50	13
Linuron	12	20	39	10
Metribuzin	9	8	18	6
Trifluralin	5	4	8	3
<u>Tank-mix materials</u>				
Alachlor + linuron	16	57	31	14
Alachlor + metribuzin	14	37	71	13
Dinoseb + naptalam	34	20	22	14
Metribuzin + trifluralin	9	29	31	9
INSECTICIDES				
<u>Single materials</u>				
Carbaryl	33	35	15	13
Methomyl	<u>c/</u>	24	10	9
Methyl parathion	-	23	35	19
Toxaphene	-	71	28	26
<u>Tank-mix materials</u>				
EPN + methyl parathion	-	31	<u>c/</u>	30
Methyl parathion + toxaphene	58	33	41	24
NEMATICIDES				
Aldicarb	<u>c/</u>	-	35	33
Ethoprop	-	-	71	71
Ethylene dibromide	-	-	39	39
FUNGICIDES				
Benomyl	-	29	45	25
PCNB + etridiazole	-	58	-	58

- None reported.

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ A coefficient of variation is the standard error of the estimate divided by acres treated times 100. A coefficient of variation describes the relative variation or precision of the estimate. An estimate is more precise the lower the value of the coefficient.

c/ Use of this material at the regional level was not significant and was reported in the "other" or "total" category.

Appendix Table 2. Percentage of soybean herbicide acre-treatments by primary grasses controlled as reported by farmers in the major producing regions, 1980 a/

	:	North Central	:	Mississippi	:	:
Herbicides, grasses	:	States	:	Valley	:	Southeast : Total

- None reported.

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Includes panicum, 7 percent.

Appendix Table 3. Percentage of soybean herbicide acre-treatments by primary broadleaf weeds controlled as reported by farmers in the major producing regions, 1980 ^{a/}

	: North	:	:	:
	: Central	: Mississippi	:	:
Herbicides, broadleaf weeds	: States	: Valley	: Southeast	: Total
	----- Percent -----			
<u>Alachlor</u>				
Cocklebur	7	8	12	8
Morningglory	2	5	8	3
Pigweed	2	7	6	3
Other	8	7	3	7
<u>Bentazon</u>				
Canada thistle	6	-	-	3
Cocklebur	55	92	90	74
Morningglory	3	3	-	3
Ragweed	2	1	5	2
Smartweed	3	-	-	1
Velvetleaf	17	-	-	8
Other	14	4	5	10
<u>Metribuzin</u>				
Cocklebur	32	35	41	34
Morningglory	1	13	18	7
Pigweed	7	6	3	6
Ragweed	7	2	3	5
Sicklepod	1	5	10	3
Smartweed	4	-	-	2
Velvetleaf	15	-	-	8
Other	9	10	12	10
<u>Trifluralin</u>				
Cocklebur	6	6	15	7
Pigweed	4	1	8	3
Velvetleaf	3	-	-	2
Other	3	2	3	2

- None reported.

^{a/} "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

Appendix Table 4. Percentage of soybean insecticide acre-treatments by primary insects controlled as reported by farmers in the major producing regions, 1980 a/

	: North Central	: Mississippi	:	
Insecticides, insects	: States	: Valley	: Southeast	: Total
	----- Percent -----			
<u>Carbaryl</u>				
Armyworm	13	87	37	40
Bean leaf beetle	11	-	4	5
Cabbage looper	-	-	4	3
Corn earworm	-	-	30	20
Cutworm	-	-	5	3
Green cloverworm	-	-	7	5
Mexican bean beetle	66	-	-	12
Other beetles	-	-	4	2
Velvetbean caterpillar	-	13	9	8
Other	10	-	-	2
<u>Methomyl</u>				
Armyworm	-	36	21	23
Bean leaf beetle	-	-	2	2
Cabbage looper	-	13	11	11
Corn earworm	100	38	48	47
Cutworm	-	-	6	5
Grasshopper	-	7	-	1
Other beetles	-	-	6	5
Spider mite	-	-	3	3
Velvetbean caterpillar	-	-	1	1
Other	-	6	2	2
<u>Methyl parathion</u>				
Armyworm	-	10	43	19
Bean leaf beetle	-	5	-	4
Cabbage looper	-	11	-	8
Cutworm	-	5	-	4
Other beetles	-	11	-	8
Threecornered alfalfa hopper	-	11	-	8
Velvetbean caterpillar	-	32	10	26
Other	-	15	47	23

- None reported.

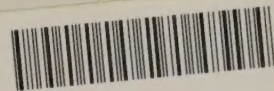
a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

Appendix Table 5. Percentage of soybean fungicide acre-treatments by primary diseases controlled as reported by farmers in the major producing regions, 1980 a/

	:	North Central	:	Mississippi	:	:
Fungicides, diseases	:	States	:	Valley	:	Southeast : Total
				<u>Percent</u>		
<u>Benomyl</u>						
Anthracnose	-	7	-		4	
Leaf blight	-	27	12		22	
Leaf spot	-	7	-		4	
Pod and stem blight	-	59	88		70	
<u>PCNB + etridiazole</u>						
Brown spot	-	100	-		100	

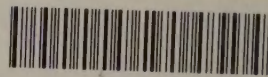
- None reported.

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.



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